

Multi-Higgs Production: Implications for Electroweak Phase Transitions and Future Collider Prospects

The production of three Higgs bosons represents both a stretch goal for the LHC and a strategic objective for future collider projects. In this particular work, currently in progress and nearing completion, we delve into the phenomenological prospects of neutral triple Higgs production compared to di-Higgs production across various Higgs-sector extensions (R2HDM, C2HDM and N2HDM), all within the context of a strong first-order electroweak phase transition. We incorporate constraints from existing exotic particle searches and Higgs boson measurements to further refine the parameter space of these models. The analysis reveals that scalar sector resonance contributions can significantly enhance triple Higgs production, despite the small Standard Model (SM) baseline expectation. Notably, one can identify potential enhancements up to 50 times the SM predictions, underscoring the importance and feasibility of experimental efforts at the High-Luminosity LHC (HL-LHC). This investigation not only motivates experimental pursuits but also sheds light on the thermal history of our universe, offering valuable insights into fundamental physics and the evolution of the cosmos.

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